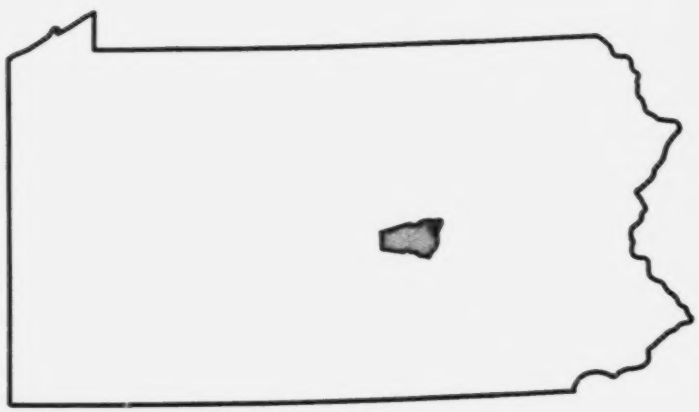
54-c-31 FEMA 209:425387

COMPLETED 36

FLOOD INSURANCE STUDY

ORIGINAL

BOROUGH OF SELINSGROVE, PENNSYLVANIA
SNYDER COUNTY



MAY 17, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 425387

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Authority and Acknowledgements	1
	1.3 Coordination	1
2.0	AREA STUDIED	2
	2.1 Scope of Study	2
	2.2 Community Description	2
	2.3 Principal Flood Problems	4
	2.4 Flood Protection Measures	5
3.0	ENGINEERING METHODS	7
	3.1 Hydrologic Analyses	7
	3.2 Hydraulic Analyses	8
4.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	10
	4.1 Flood Boundaries	10
	4.2 Floodways	11
5.0	INSURANCE APPLICATION	15
	5.1 Reach Determinations	15
	5.2 Flood Hazard Factors	15
	5.3 Flood Insurance Zones	17
	5.4 Flood Insurance Rate Map Description	17

TABLE OF CONTENTS - continued

	Page
6.0 OTHER STUDIES	18
7.0 LOCATION OF DATA	18
8.0 BIBLIOGRAPHY AND REFERENCES	18

FIGURES

Figure 1 - Vicinity Map	3
Figure 2 - Floodway Schematic	14

TABLES

Table 1 - Summary of Discharges	8
Table 2 - Floodway Data	12 - 13
Table 3 - Flood Insurance Zone Data	16

EXHIBITS

Exhibit 1 - Flood Profiles	
Susquehanna River	Panel 01P
Penns Creek	Panel 02P
South Tributary	Panels 03P-04P
Exhibit 2 - Flood Boundary and Floodway Map	

PUBLISHED SEPARATELY:

Flood Insurance Rate Map

FLOOD INSURANCE STUDY
BOROUGH OF SELINSGROVE, PENNSYLVANIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Borough of Selinsgrove, Snyder County, Pennsylvania, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This information will allow Selinsgrove to continue participation in the regular program of flood insurance by the Federal Emergency Management Agency (FEMA) with the most current data. Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally-supported studies are based. These criteria take precedence over the minimum federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3. In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study represent a revision of the Flood Insurance Rate Maps published in 1973. This study was prepared by Bourquard and Berger Associates for the Federal Emergency Management Agency, under Contract No. H-4763. This work was completed in March 1980.

1.3 Coordination

In May 1978, streams previously studied and those requiring revisions were identified at an initial Consultation and Coordination Officer's (CCO) meeting attended by representatives of the FEMA, the Borough of Selinsgrove, and Bourquard and Berger Associates (the study contractor). Follow-up contacts were made in December 1979 with community officials and several residents who live along South Tributary.

Personal visits were made to offices of the Baltimore District of the U. S. Army Corps of Engineers (COE), the Susquehanna River Basin Commission, the Soil Conservation Service (SCS), the U. S. Geological Survey (USGS), and the Pennsylvania Department of Environmental Resources to secure available information pertinent to this study. On December 7, 1981, the results of the study were reviewed at a final CCO meeting held with representatives of the FEMA, the borough, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Borough of Selinsgrove, Snyder County, Pennsylvania. The area of study is shown on the Vicinity Map (Figure 1).

The Susquehanna River, Penns Creek, and South Tributary from its confluence with Penns Creek to West Sassafras Street were studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction for the next five years, through March 1985.

Tributary 1 and South Tributary above West Sassafras Street were studied by approximate methods. Approximate methods of analysis were used to study those areas having low development potential and minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the FEMA.

2.2 Community Description

The Borough of Selinsgrove is located in the northeastern portion of Snyder County in central Pennsylvania. It is situated near the junction of three major north-south highways, U. S. Routes 11, 15, and 522. The borough is the most densely populated municipality in Snyder County (Reference 1). Since most of it is developed to the maximum, the population has been fairly constant, numbering 5,116 in 1970 and 5,160 in 1975 (References 2 and 3). Selinsgrove was incorporated in 1827 (Reference 4).

Land use in the borough is roughly divided into 17.4 percent residential, 3.5 percent industrial and commercial, 13.4 percent public, semi-public, and institutional, 16 percent utilities, and 43 percent open space and recreation (Reference 1). The central business district, which is composed of residences and retail commercial establishments, is along Market Street. This area also houses several public and semi-public

BEST DOCUMENT AVAILABLE

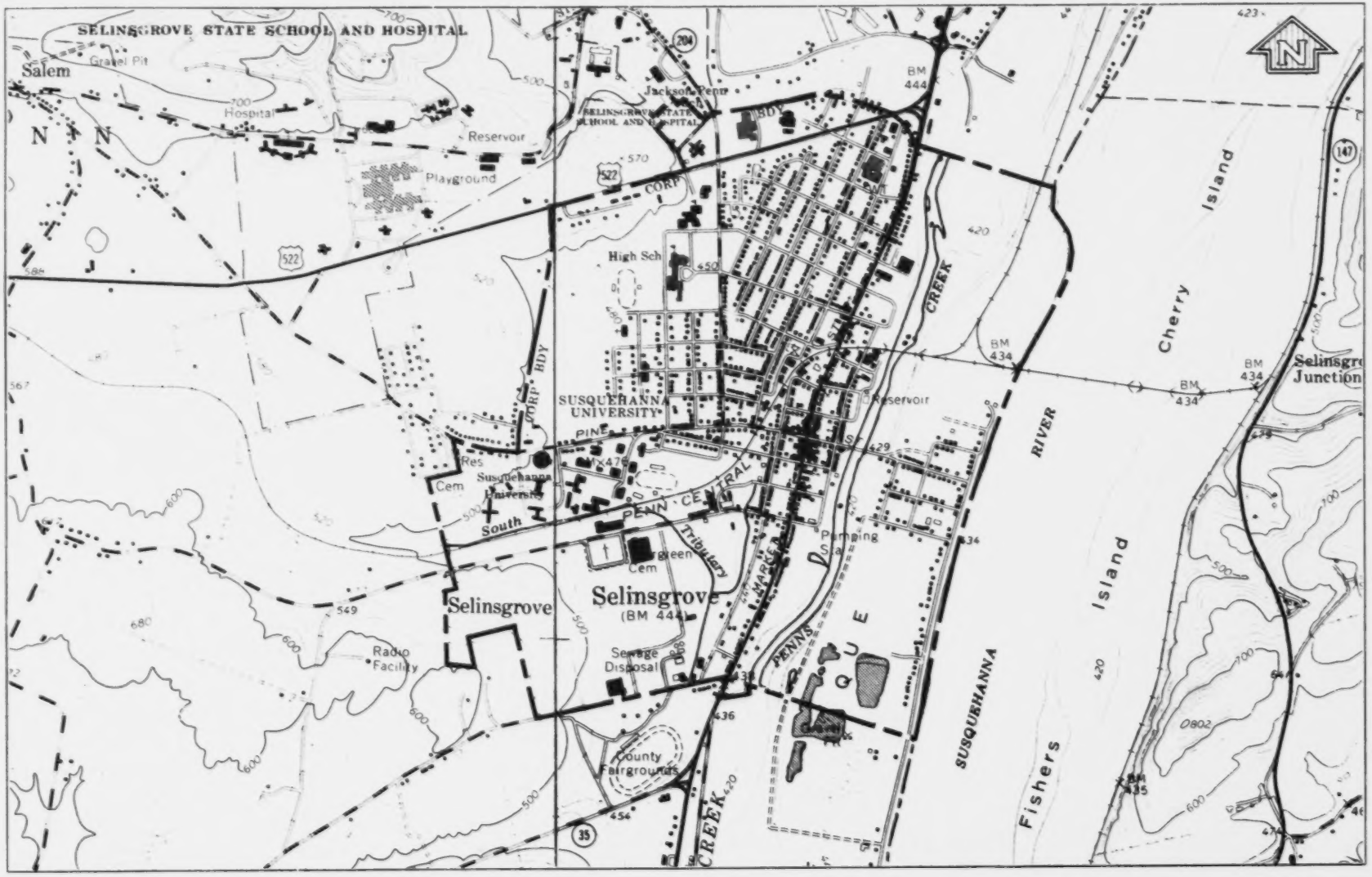


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

VICINITY MAP

structures. The north-central and northeastern portions of the borough form residential neighborhoods along with a large tract of land owned by the school district. The entire eastern portion of Selinsgrove, located on the Isle of Que, is within the flood plain of the Susquehanna River and is mostly residential (Reference 1).

Industry in Selinsgrove employs approximately 25 percent of the manufacturing work force in Snyder County. Almost half of that employment is in the classification of fabricated metal products. Employment in the public sector is also significant (Reference 1).

The climate of Selinsgrove is generally humid continental, but is modified by the effects of the Atlantic Ocean and the Gulf of Mexico. The average precipitation ranges between 40 and 42 inches annually and is normally well distributed throughout the year (References 5 and 6).

2.3 Principal Flood Problems

The history of flooding within Selinsgrove indicates that flooding can occur during any season of the year. Flooding from thunderstorms is most severe on smaller tributaries such as South Tributary and Tributary 1. On the average, 41 thunderstorms occur annually, with 60 percent occurring in summer, 25 percent in spring, 14 percent in fall, and 1 percent in winter (References 5 and 6). Larger, area-wide storms such as Tropical Storm Agnes in June 1972 are more infrequent. However, due to the large watershed of the Susquehanna River and Penns Creek, the resulting floods inundate large amounts of flood plain land.

Although there are no gages on the Susquehanna River at Selinsgrove, historical and systematic records obtained from the USGS for the nearest gage at Sunbury, Pennsylvania, indicate that there have been four major floods on the Susquehanna River in the Selinsgrove area in the last 100 years. In order of decreasing magnitude, the floods occurred on June 24, 1972, March 19, 1936, May 29, 1946, and March 11, 1964. Since there has been substantial upstream reservoir and protective levee construction in the Susquehanna River basin during the past 100 years, discharge-frequency relationships from the past are not compatible with those developed later, as basin conditions have changed. However, it has been estimated that the June 1972 flood had a recurrence interval of 170 years.

The USGS gage No. 5550 at Penns Creek, Pennsylvania, and upstream of the borough, measures the flow of water from a 301-square mile portion of the Penns Creek watershed. Its systematic record, dating from 1930, provides a history of flooding that is considered more applicable in determining flood hazards along Penns Creek in Selinsgrove than it was before the construction of the U. S. Route 11 and 15 bypass.

Prior to this construction, Penns Creek flooding in Selinsgrove was primarily the result of the Susquehanna River entering the Penns Creek channel. As an example, the worst headwater flood of record on Penns Creek occurred on June 23, 1972. It was followed the next day by backwater from the Susquehanna River that caused a further increase in flood stage of 6 to 7 feet. Following the construction of the bypass for U. S. Routes 11 and 15, flooding along Penns Creek has now been determined to be the chief source of flooding for the more frequent recurrences.

The highest recorded discharges at the gage were 34,600 cubic feet per second (cfs) on June 23, 1972, 19,800 cfs on September 16, 1934, and 15,700 cfs on March 18, 1936. These floods had recurrence intervals of 240 years, 40 years, and 20 years, respectively. Floods in Selinsgrove have occurred during seasons of spring rainfall and snowmelt, and from tropical storms moving north along the Atlantic coastline.

As a contrast, flooding from the June 1972 flood on South Tributary appears from a comparison of water-surface profiles against high-water marks obtained from residents and businesses along South Tributary to be less than a 10-year flood. Upstream of the study area, however, several alternative flow paths do exist for the diversion of discharge into other watersheds, and it is possible that flooding from the June 1972 flood could have reached higher relative stages in upstream areas before reaching the diversions.

Since the Susquehanna River and Penns Creek flow parallel to the main business district corridor along Market Street, considerable potential damage can be done to this area in the event of floods. South Tributary also causes damage, particularly in the area upstream of Sassafras Avenue, which is not included in this study. In the area covered by this study, considerable potential exists for new industrial-type development to be located in the flood plain area. Within this area, there was 2.7 feet of water above the floor of the Selinsgrove Sewage Treatment Plant and 22 inches above the floor in a Pennsylvania Department of Transportation maintenance building during the June 1972 flood.

2.4 Flood Protection Measures

Eleven upstream dams contribute to the reduction of flood hazard from the Susquehanna River, including four in the West Branch Susquehanna River subbasin and seven in the other Susquehanna River subbasins. Flood hazard reduction in the West Branch Susquehanna River subbasin is aided by: Blanchard Dam, located approximately 12 miles southwest of Lock Haven, Pennsylvania, on Bald Eagle Creek; Stevenson Dam, located approximately 8 miles northeast of Sinnemahoning, Pennsylvania, on First Fork Sinnemahoning Creek; Kettle Creek Dam, located approximately 8 miles

northeast of Westport, Pennsylvania, on Kettle Creek; and Curwensville Dam, located approximately 7 miles southwest of Clearfield, Pennsylvania, on the West Branch Susquehanna River.

Flood hazard reduction in the other Susquehanna River subbasins is aided by: Stillwater Reservoir, located approximately 9 miles north of Carbondale, Pennsylvania, on the Lackawanna River; East Sidney Lake, located approximately 8 miles east of Sidney, New York, on Ouleout Creek; Whitney Point Dam, located approximately 1 mile north of Whitney Point, New York, on the Otselic River; Almond Dam, located approximately 2 miles northwest of Hornell, New York, on Canacadea Creek; Arkport Dam, located approximately 5 miles northeast of Hornell, New York, on the Canisteo River; the Tioga-Hammond Dam complex, located approximately 20 miles southwest of Elmira, New York, on the Tioga River and Crooked Creek; and the Cowanesque Lake project located on the Cowanesque River approximately 2.2 miles above the confluence with the Tioga River at Lawrenceville, Pennsylvania.

There are no flood control dams within the Penns Creek watershed. A flood warning system was initiated in December 1978 by the Snyder County Civil Defense Agency and consists of 12 rain gages and six creek gages in the Penns Creek and Middle Creek watersheds. The project was accomplished through the cooperative efforts of county officials, the state government, and the Susquehanna University Institute of Environmental Studies.

In the Penns Creek watershed, manually-read stream gages are located at the bridge leading to Camp Karoundinha in western Union County at the State Route 104 bridge near the Town of Penns Creek, and at a bridge over Penns Creek in Kratzerville. A temporary gage has also been installed near Selinsgrove. All rainfall gages and stream gages are read manually, and the resulting data are intended to enable Civil Defense officials to build a data base for predicting the height and timing of flooding as the flood wave moves downstream.

A proposed flood protection project by the Pennsylvania Department of Transportation was studied in June 1973 for the portion of South Tributary upstream of Sassafras Street and flowing past Susquehanna University (Reference 7). The recommended plan of protection involved 2,385 feet of excavated trapazoidal channel, 790 feet of retaining wall, 70 feet of earth levee, and rip-rap protection for all earth channel slopes. This project would not influence the portion of South Tributary covered in this study, other than eliminating several of the alternative flow paths upstream of Sassafras Street. Further action on the project has been withheld due to an unfavorable cost-benefit ratio.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one-percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten) and, for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

A discharge-frequency relationship for the Susquehanna River was obtained from the Flood Insurance Studies for the Townships of Monroe, Penn, and Lower Augusta (References 8, 9, and 10). This was determined using a statistical analysis performed by the COE for the stream gage at Sunbury, which is located approximately 5 miles upstream from the northern boundary of Selinsgrove. The gage has 43 years of systematic record and a historical record that extends back to 1865. This analysis followed the standard log-Pearson Type III method (Reference 11). Flood-frequency curves were adjusted for the effects of upstream reservoirs.

A peak discharge-frequency relationship for Penns Creek was selected with consideration given to the Flood Insurance Studies for the Townships of Monroe and Penn and the original Flood Insurance Study for Selinsgrove (References 8, 9, and 12). A comparison of the previously developed relationships with a peak discharge relationship developed from a regional hydrologic method and with an adjusted peak discharge-frequency relationship from the USGS gaging station No. 5550 was made at a key location along Penns Creek (Reference 13). The gaging station relationship was developed in accordance with the log-Pearson Type III method and was transferred to the site for comparison by a drainage area

proportionment formula. The results of this comparison indicated that the peak discharge-frequency relationships determined for the Townships of Monroe and Penn could be adopted for use in this study.

For South Tributary, a previous discharge-frequency relationship was available from the Pennsylvania Department of Environmental Resources (Reference 7). This was compared to several regional hydrologic methods (References 13, 14, and 15). The regional methods were either too low for the urbanized conditions of the watershed or not applicable at this drainage area size.

A summary of drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges".

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
SUSQUEHANNA RIVER					
At the downstream corporate limits	18,434	320,000	460,000	540,000	790,000
PENNS CREEK					
Upstream of the confluence of Middle Creek	377	13,800	22,500	28,000	44,000
SOUTH TRIBUTARY					
At the confluence with Penns Creek	2	600	900	1,230	2,800

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

The hydraulic analyses for the Susquehanna River and Penns Creek were obtained from the Flood Insurance Studies for the Townships of Monroe, Penn, and Lower Augusta (References 8, 9, and 10).

Cross sections for the backwater analyses of South Tributary were obtained from aerial photographs flown in December 1978 (Reference 16). The below-water sections were obtained by a stream bottom profile. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen using engineering judgment, field survey, and aerial photographs (Reference 16). The channel "n" value for the Susquehanna River was 0.033, and the overbank "n" values ranged from 0.064 to 0.065. The channel "n" values for Penns Creek ranged from 0.028 to 0.030, and the overbank "n" values ranged from 0.045 to 0.052. For South Tributary, the channel "n" value was 0.050, and the overbank "n" values ranged from 0.060 to 0.100.

Water-surface elevations of floods of the selected recurrence intervals were computed through the use of the COE HEC-2 step-backwater computer program (Reference 17). Starting water-surface elevations for the Susquehanna River and Penns Creek were obtained from the Flood Insurance Study for the Township of Penn (Reference 9). Starting water-surface elevations for South Tributary were determined using the slope/area method.

Hydraulic model verification against high-water marks was checked for the Susquehanna River by utilizing high-water marks from the June 1972 flood. It is understood that hydraulic model verification against high-water marks for the June 1972 flood for Penns Creek was not possible (Reference 7).

Since no discharge values were available for South Tributary, a comparison of the computed water-surface profiles against high-water data obtained from residents, businesses, borough officials, and employees was not definite and consistent. The June 1972 flood had affected flooding on Penns Creek in a way which increased the inconsistency of the high-water data.

Flooding on Penns Creek preceded the Susquehanna River peak stage and caused backwater to enter South Tributary on June 23, 1972. This was followed by the peak of the Susquehanna River on the next day, which again caused backwater to enter Penns Creek and, thus, South Tributary. The observations from those interviewed are thought to be inconsistent due to the difficulty of establishing exactly which day the observation was made.

In June 1972, the U. S. Route 11 and 15 bypass had not yet been constructed. Since then, the bypass has been completed and, in effect, acts as a levee preventing direct flooding of the borough from the Susquehanna River for floods with less than a 50-year recurrence interval. For floods greater than the 50-year flood, the highway embankment upstream of the U. S. Route 15 bridge over the Conrail bridge can be overtopped by the Susquehanna River. However, it has been assumed that the timing and amount of the diverted flow from the Susquehanna River, as well as the Penns Creek backwater elevation and the submergence

on the U. S. Route 15 weir, will combine to cause elevations no higher in Penns Creek than that obtained for direct flooding from the Penns Creek watershed for the 100-year flood. For the 500-year flood, the Susquehanna River will enter Penns Creek and control all elevations within it.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. Locations of the elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed, and dams and other flood control structures operate properly and do not fail.

For the streams studied by approximate methods, the 100-year elevation was obtained from the Pennsylvania Department of Environmental Resources (Reference 7).

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1"=400' with a contour interval of 5 feet (Reference 18). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year boundary has been shown.

For the streams studied by approximate methods, the boundary of the 100-year flood was delineated using the topographic maps referenced above (Reference 18).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, may not be subject to flooding. Owing to limitations of the map scale and lack of detailed topographic data, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood heights. Minimum standards of the FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study for the Susquehanna River and Penns Creek were computed on the basis of equal conveyance reduction from each side of the flood plains. Due to the steepness of the stream channel, the variation of the stream valley geometry and the constrictions posed by many of the small bridges across South Tributary, the development of the floodway for South Tributary had to depart somewhat from the criteria of one foot equal conveyance reduction. At controls, the floodway calculation was either computed with different criteria or was terminated in order to avoid the build-up of excessive velocities and the delineation of a floodway with a greatly varying topwidth. In general for South Tributary, equal conveyance reduction using an 0.5-foot increase of the water surface over the 100-year water-surface elevation was used for the defined encroachment condition in the downstream half of the stream. In the upstream half, various topwidths centered over the channel were designated for the encroachment condition. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

BEST DOCUMENT AVAILABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						(FEET NGVD)		
Susquehanna River								
A	1,465[1]	3,157[3]	71,197	7.6	435.0	435.0	435.4	0.4
B	4,130[1]	2,931[3]	68,114	7.9	436.1	436.1	436.5	0.4
C	5,745[1]	4,458[3]	80,756	6.9	437.7	437.7	438.2	0.5
D	6,965[1]	4,967[3]	97,979	5.9	438.5	438.5	439.3	0.8
Penns Creek								
A	15,600[2]	950[3]	9,156	3.1	432.7	431.7[4]	432.4	0.7
B	16,230[2]	761	8,397	3.3	432.7	431.9[4]	432.6	0.7
C	18,210[2]	602	6,775	4.1	432.7	432.1[4]	433.0	0.9
D	19,190[2]	312	4,635	6.0	432.8	432.8	433.8	1.0
E	20,460[2]	465	6,538	4.3	433.6	433.6	434.6	1.0
F	20,685[2]	540	9,047	3.1	433.9	433.9	434.9	1.0
G	22,980[2]	1,199	14,784	1.9	434.4	434.4	435.4	1.0

[1]Feet above corporate limits (extended)
[2]Feet above confluence with the Susquehanna River
[3]This width extends beyond corporate limits
[4]Elevation computed without consideration of backwater effects from the Susquehanna River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

FLOODWAY DATA

SUSQUEHANNA RIVER AND PENNS CREEK

BEST DOCUMENT AVAILABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
South Tributary								
A	215	75[2]	216	4.5	432.7	422.0[3]	422.5	0.5
B	1,000	124	570	2.2	437.0	437.0	437.1	0.1
C	1,185	200	582	2.1	437.3	437.3	437.5	0.2
D	1,580	120	563	2.2	439.3	439.3	440.1	0.8
E	2,145	376	1,040	1.2	440.5	440.5	441.5	1.0
F	2,750	100	195	6.3	444.5	444.5	444.5	0.0
G	3,410	45	245	5.0	451.1	451.1	451.8	0.7

[1]Feet above confluence with Penns Creek

[2]This width extends beyond corporate limits

[3]Elevation computed without consideration of backwater effects from the Susquehanna River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

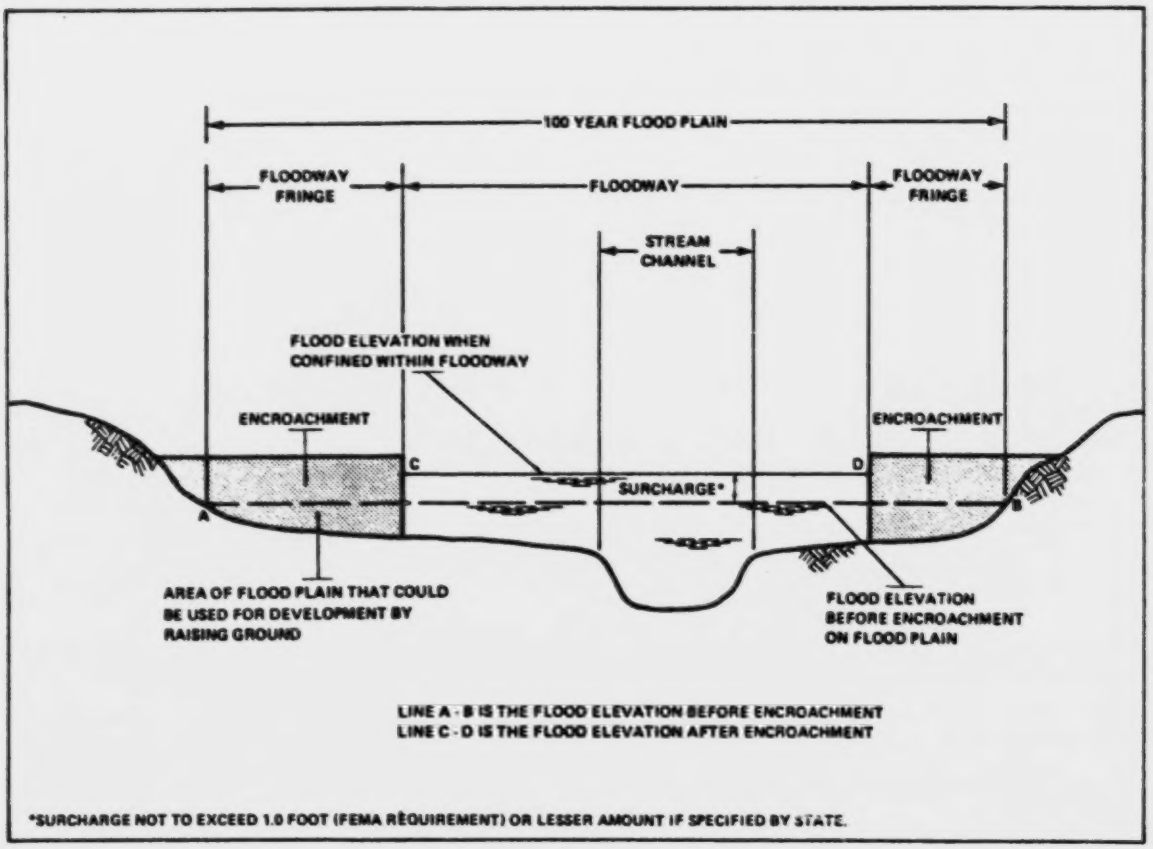
FLOODWAY DATA

SOUTH TRIBUTARY

BEST DOCUMENT AVAILABLE

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway widths of the Susquehanna River, Penns Creek, and South Tributary extend beyond the corporate limits.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC

Figure 2

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "With Floodway" elevations presented in Table 2 for certain downstream cross sections of Penns Creek and South Tributary are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source affecting the Borough of Selinsgrove.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the Borough of Selinsgrove are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors

The FHF is the FEMA device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Susquehanna River Backwater Area Affecting Penns Creek and South Tributary	01	-6.4	-1.9	+4.6	065	A13	433
Reach 1	01	-6.9	-2.6	+4.0	070	A14	Varies
Reach 2	01	-7.9	-3.0	+4.2	080	A16	Varies
Penns Creek							
Reach 1	01	-4.9	-2.0	+4.0	050	A10	Varies
South Tributary							
Reach 1	01	-2.6	-1.2	+5.4	025	A5	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

FLOOD INSURANCE ZONE DATA

SUSQUEHANNA RIVER,
PENNS CREEK AND SOUTH TRIBUTARY

BEST DOCUMENT AVAILABLE

foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the Borough of Selinsgrove was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A5, A10, A13, A14, and A16:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also, areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the Borough of Selinsgrove.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Borough of Selinsgrove is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FEMA.

6.0 OTHER STUDIES

Flood Insurance Studies for the Townships of Monroe and Lower Augusta have been completed (References 8 and 10). The results of this study is in exact agreement with the results of those studies.

Flood Insurance Studies for the Townships of Penn and Jackson are currently being prepared (References 9 and 19). The results of those studies will be in exact agreement with the results of this study.

Discharge-frequency analyses for the original Type 15 Flood Insurance Study for Selinsgrove were made prior to the 1972 flood of record on the Susquehanna River and Penns Creek (Reference 12). This study incorporates relationships with the effect of Agnes taken into account. No consideration was given to the effect of the existing flood control reservoirs located on the Susquehanna River, upstream of the study area in the original study. Although the peak discharges differ only slightly, the frequency curves used in this study do consider the effect of these reservoirs. The original study also did not take into account the construction of the U. S. Route 11-15 bypass, which ended on April 23, 1977. This bypass circumvents Selinsgrove to the east and runs parallel with the Susquehanna River. In effect, it can act as a levee preventing direct flooding of Selinsgrove from the Susquehanna River at flood stages of frequent recurrence.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Insurance and Mitigation Division of the Federal Emergency Management Agency, Regional Director, Region III Office, Curtis Building, Room 700, Sixth and Walnut Streets, Philadelphia, Pennsylvania 19106.

8.0 BIBLIOGRAPHY AND REFERENCES

1. Local Government Research Corporation, Comprehensive Development Plan Update, Borough of Selinsgrove, Snyder County, Pennsylvania, State College, Pennsylvania, 1975-1976.

2. U. S. Department of Commerce, Bureau of the Census, 1970 Census of Population, Number of Inhabitants, Pennsylvania, Washington, D. C., U. S. Government Printing Office, 1971.

3. Commonwealth of Pennsylvania, Department of Commerce, Industrial Census M-5-77, Snyder County, Pennsylvania, Harrisburg, Pennsylvania.

4. Commonwealth of Pennsylvania, Department of Internal Affairs, Incorporation Dates for Pennsylvania Municipalities, Harrisburg, Pennsylvania, 1965.

5. Snyder County Planning Commission, Comprehensive Development Plan, Drainage and Surface Runoff Study, Phase I, Inventory, Middleburg, Pennsylvania, June 1960.

6. Snyder County Planning Commission, Natural Features, Surface Runoff and Sedimentation Study for Union and Snyder Counties, Middleburg, Pennsylvania, June 1977.

7. Commonwealth of Pennsylvania, Department of Environmental Resources, prepared by Erdman, Anthony, and Associates, Flood Control Planning Report for the Borough of Selinsgrove and the Township of Penn, Snyder County, Pennsylvania, Harrisburg, Pennsylvania, June 1973.

8. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Township of Monroe, Snyder County, Pennsylvania, Washington, D. C., August 2, 1976.

9. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Township of Penn, Snyder County, Pennsylvania (Unpublished).

10. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Township of Lower Augusta, Northumberland County, Pennsylvania, Washington, D. C., February 1, 1979.

11. Water Resources Council, "Guidelines for Determining Flood Flow Frequency", Bulletin 17A, Washington, D. C., June 1977.

12. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Type 15 Flood Insurance Study, Borough of Selinsgrove, Snyder County, Pennsylvania, Washington, D. C., March 19, 1973.

13. Commonwealth of Pennsylvania, Department of Environmental Resources, in cooperation with the U. S. Geological Survey, Water Resources Bulletin No. 13, Floods in Pennsylvania, A Manual for Estimation of their Magnitude and Frequency by Herbert J. Flippo, Jr., Harrisburg, Pennsylvania, October 1977.

14. U. S. Army Corps of Engineers, New York District, Hydrologic Study, Tropical Storm Agnes, New York, December 1975.

15. U. S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds, Washington, D. C., January 1975.

16. Berger Associates of Columbus, Ohio, Aerial Photographs, Borough of Selinsgrove, Snyder County, Pennsylvania, 1979.

17. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, August 1979.

18. Susquehanna River Basin Commission of Harrisburg, Pennsylvania, Topographic Maps compiled from aerial photographs, Scale 1"=400', Contour Interval 5 Feet: Borough of Selinsgrove, Snyder County, Pennsylvania, February 13, 1973.

19. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Township of Jackson, Snyder County, Pennsylvania (Unpublished).

Chow, Ven Te, ed., Handbook of Applied Hydrology, New York, McGraw-Hill, 1964.

Chow, Ven Te, Open-Channel Hydraulics, New York, McGraw-Hill, 1964.

Commonwealth of Pennsylvania, Department of Environmental Resources, Bulletin No. 9, Hydrologic Data of the June 1972 Flood in Pennsylvania, Harrisburg, Pennsylvania, August 1974.

Commonwealth of Pennsylvania, Department of Environmental Resources, Pennsylvania Gazetteer of Streams, Part I by L. C. Shaw and W. F. Busch, Harrisburg, Pennsylvania, 1971.

Delaware River Basin Commission, prepared by Anderson-Nichols, Co., Basin Wide Program for Flood Plain Delineation, June 1973.

The Pennsylvania State University, Institute for Research on Land and Water Resources, Research Publication No. 24, Effects of Agnes Floods on Annual Series in Pennsylvania by B. M. Reich, University Park, Pennsylvania, July 1973.

The Pennsylvania State University, Institute for Research on Land and Water Resources, PSU III, Flood Peak Frequency Design Manual by B. M. Reich, Y. P. King, and E. L. White, University Park, Pennsylvania, 1971.

U. S. Army Corps of Engineers, Hydrologic Engineering Center, Regional Frequency Study, Upper Delaware and Hudson River Basins, Davis, California, November 1974.

U. S. Department of Agriculture, Soil Conservation Service, Mid-Penn Soil Survey Maps for Montour, Northumberland, Snyder, and Union Counties, Pennsylvania, Washington, D. C.

U. S. Department of Agriculture, Soil Conservation Service, Snyder County Interim Soil Survey Report, Volume II, Soil Maps, Washington, D. C., 1971.

U. S. Department of the Interior, Geological Survey, Professional Paper 924, Hurricane Agnes Rainfall and Floods, June-July 1972, Washington, D. C., 1975.

U. S. Department of the Interior, Geological Survey, Map of Flood-Prone Areas, Scale 1:24,000, Contour Interval 20 Feet: Sunbury, Pennsylvania, 1973; Freeburg, Pennsylvania, 1969.

U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 Feet: Sunbury, Pennsylvania, 1965, Photorevised 1973; Freeburg, Pennsylvania, 1965, Photorevised 1973.

U. S. Department of the Interior, Geological Survey, Water Resources Data for Pennsylvania, Volume 2, Susquehanna and Potomac River Basins, Water Year 1978, Washington, D. C., 1979.

REACH 1
ZONE A14

REACH 2
ZONE A16

CORPORATE LIMITS (EXTENDED)

CONRAIL

CORPORATE LIMITS (EXTENDED)

ELEVATION IN FEET (NGVD)

450
440
430
420
410
400

0 1 2 3 4 5 6 7 8

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE CORPORATE LIMITS (EXTENDED)

A B C D

LEGEND

- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

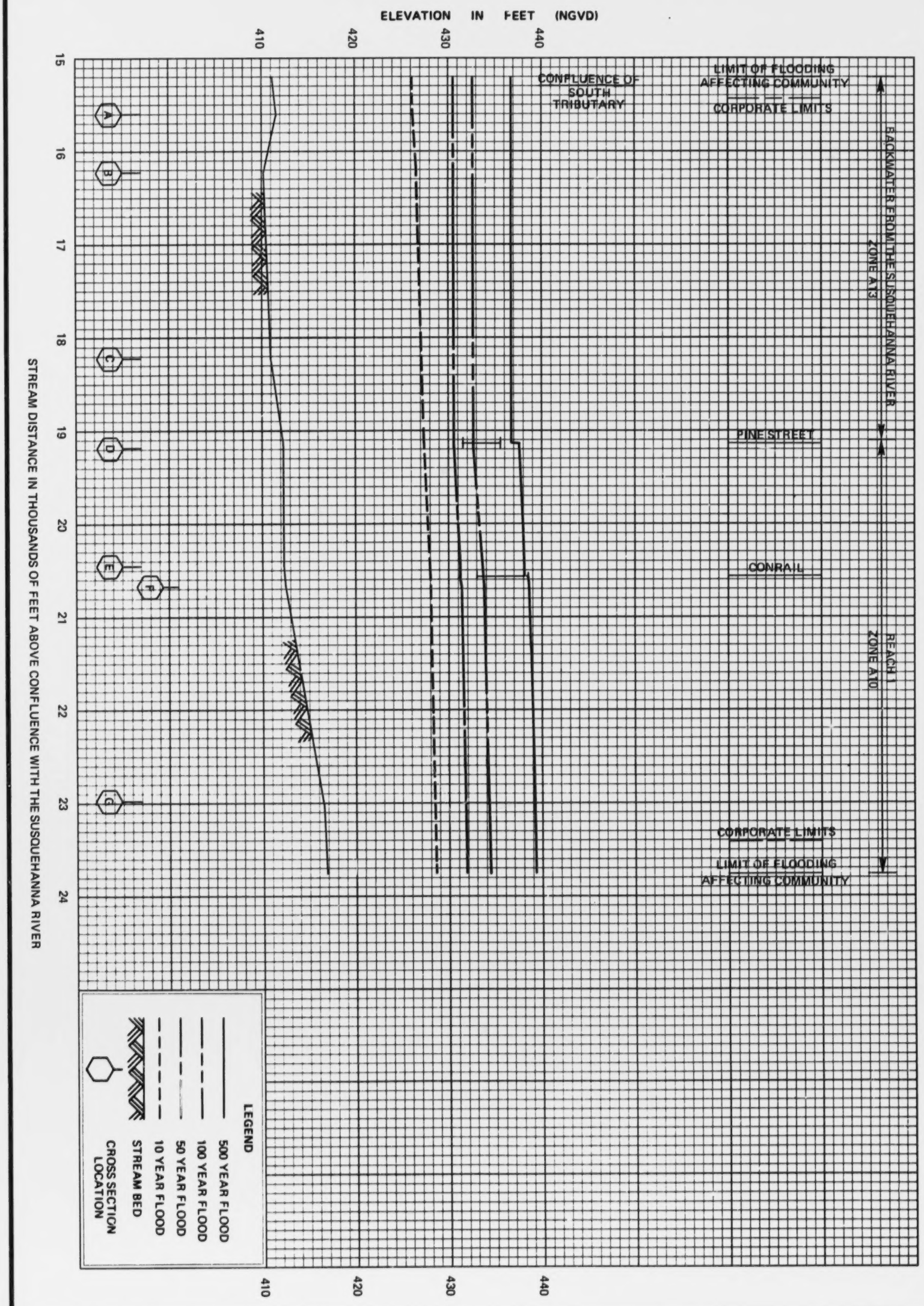
FLOOD PROFILES

SUSQUEHANNA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

01P



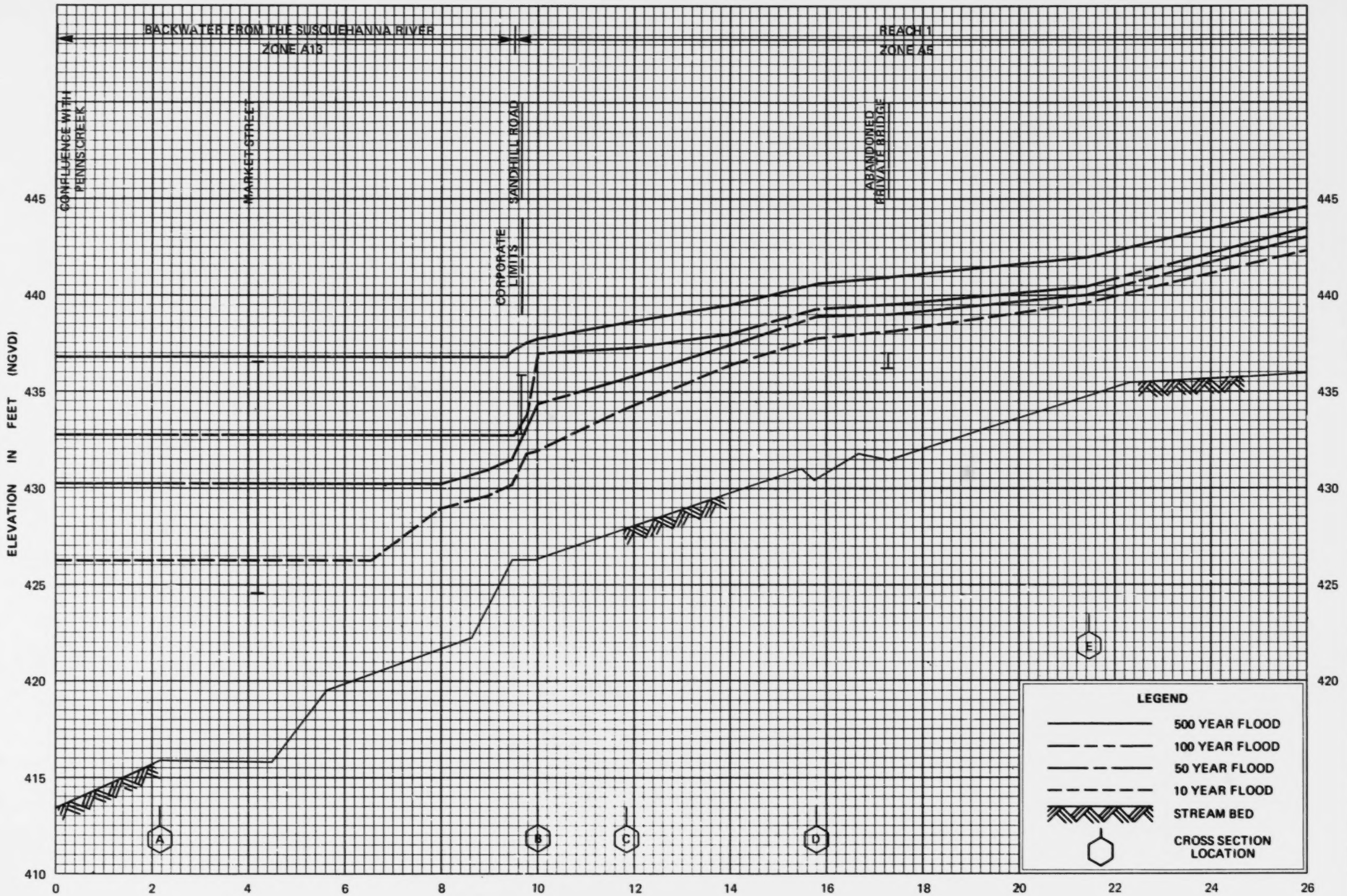
FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

FLOOD PROFILES

PENNS CREEK

02P



FLOOD PROFILES

SOUTH TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

03P

ELEVATION IN FEET (NGVD)

435 440 445 450 455

26 28 30 32 34 36

STREAM DISTANCE IN HUNDREDS OF FEET ABOVE CONFLUENCE WITH PENNS CREEK

F

G

REACH 1
ZONE A5

LIMIT OF
DETAILED STUDY

WEST SASSAFRAS
STREET

LEGEND

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

STREAM BED

CROSS SECTION
LOCATION

FEDERAL EMERGENCY MANAGEMENT AGENCY

BOROUGH OF SELINSGROVE, PA
(SNYDER CO.)

FLOOD PROFILES

SOUTH TRIBUTARY

04P